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Config impact examination Status and further works

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Background

- **Facts**
  - Embedded engineers LOVE small kernel.
  - To make small kernel,
    you need to configure your kernel very carefully.
  - Num of config items > 3000

- **Issues**
  - Kernel size and memory usage impacts of config items are unknown.
  - Trial-and-error approach is impractical.
  - Trend of kernel footprint along versions is unknown.

＊Reference : size of tar.bz2 file
- 2.6.0 : 32.5[MB]
- 2.6.8 : 34.8[MB]
- 2.6.15 : 38.9[MB]

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Project overview

- **Objective**
  - Making clear impact of config items for kernel size and memory usage

- **Goal**
  - Develop and provide examination tool
  - Provide data
    - size impact of config items
      - Derived from kernel file size measurement
    - Memory usage impact of config items
      - Derived from memory usage measurement just after boot

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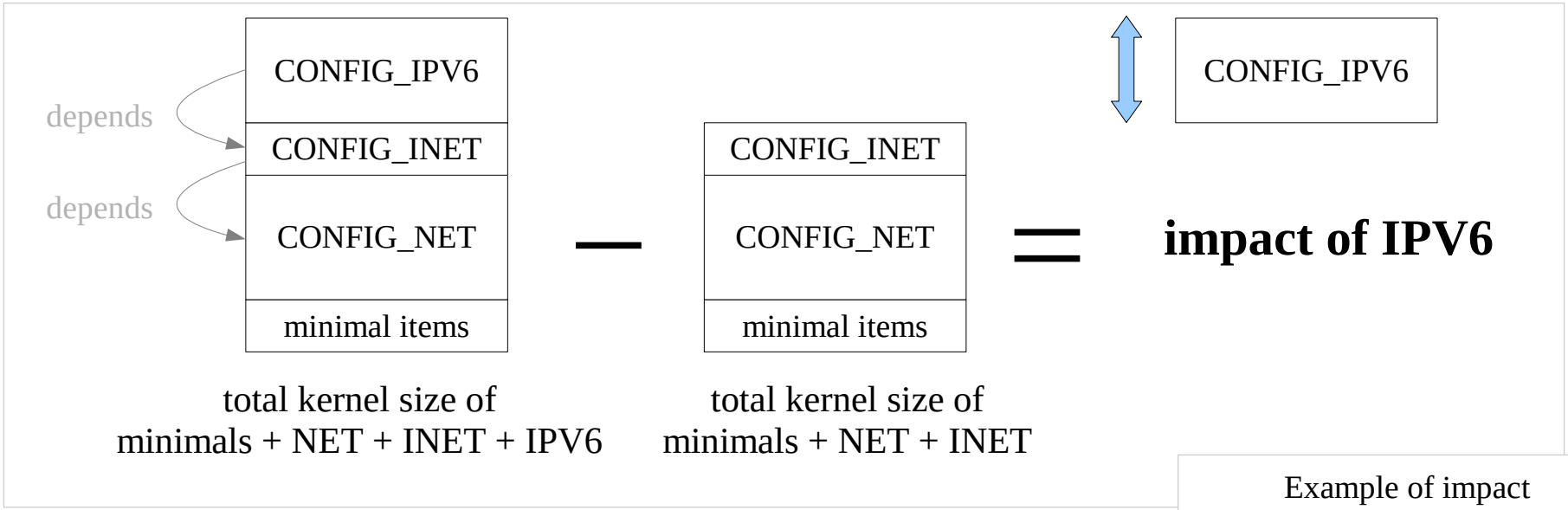
Examination tool (1)

- **Automatic measurement**
  - Make kernels whose enabled config items are minimal items + one of target items
  - Measure file size of kernel image.
  - Install, reboot, and measure memory usage just after booting.
  - Calculate impacts of config items shown as below.



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Examination tool (2)

- **Result visualization**
  - Provide examination results graphically.
    - Impacts for static size
    - Impacts for memory usage
  - Condition comparison is available.
    (kernel versions, architectures, etc.)
  - Inspired by Bloatwatch

(=> demo)

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Examining conditions

- **Minimal config items for minimal kernel**
  - Minimal configs just only to boot are enabled.
  - UP kernel
- **Target config items : About 200**
  - Select popular items for embedded.
  - Except for items which have global effect.
    (ex : smp, pm, printk support etc.)
- **Target versions**
  - 2.6.0, 2.6.4, 2.6.8, 2.6.10, 2.6.12.6, 2.6.15.6
- **Target architectures**
  - i386, ARM

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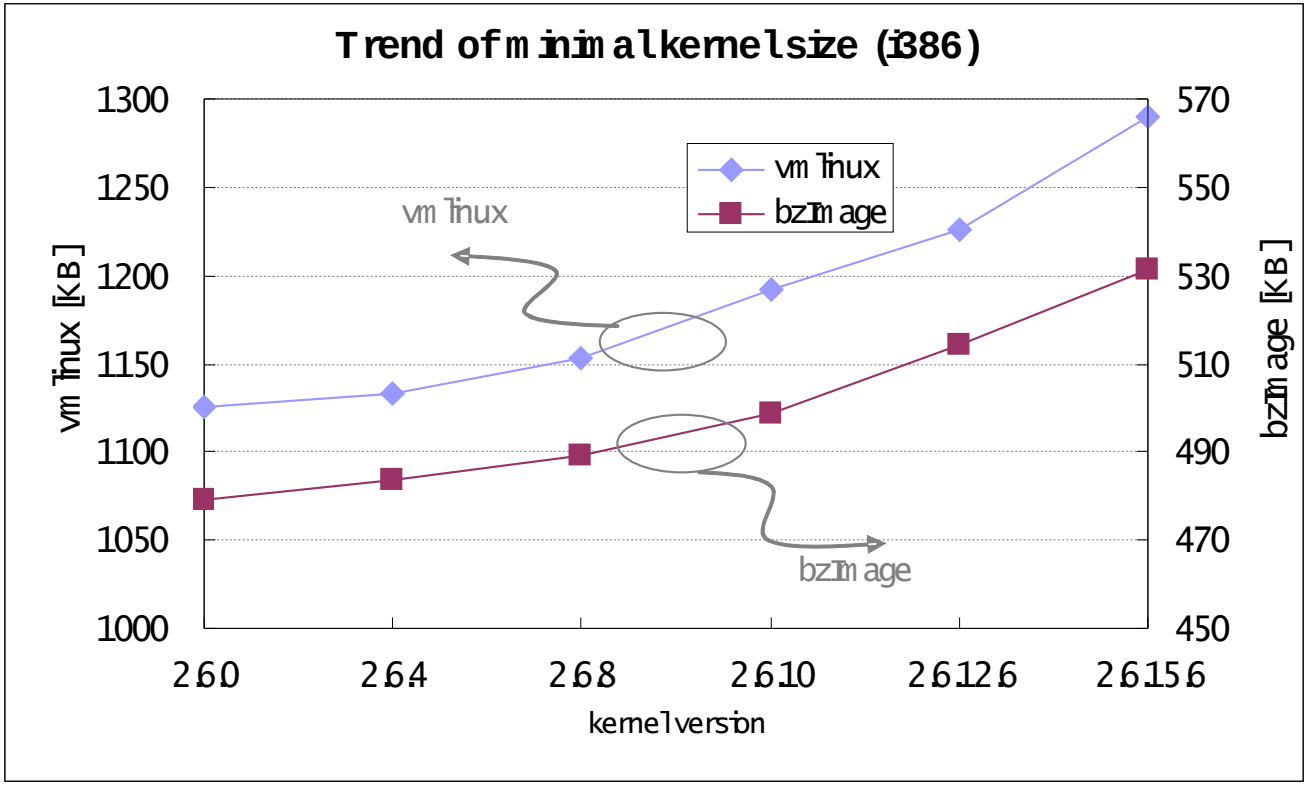
Examining result about size (1)

- **Minimal kernel**
  - Size increase is about 10% from 2.6.0 to 2.6.15

	vmlinux	bzImage
2.6.0	1126[KB]	479[KB]
2.6.15.6	1290[KB]	532[KB]
increase	164[KB]	53[KB]



Note(1) : gcc 3.3.5, binutils 2.15

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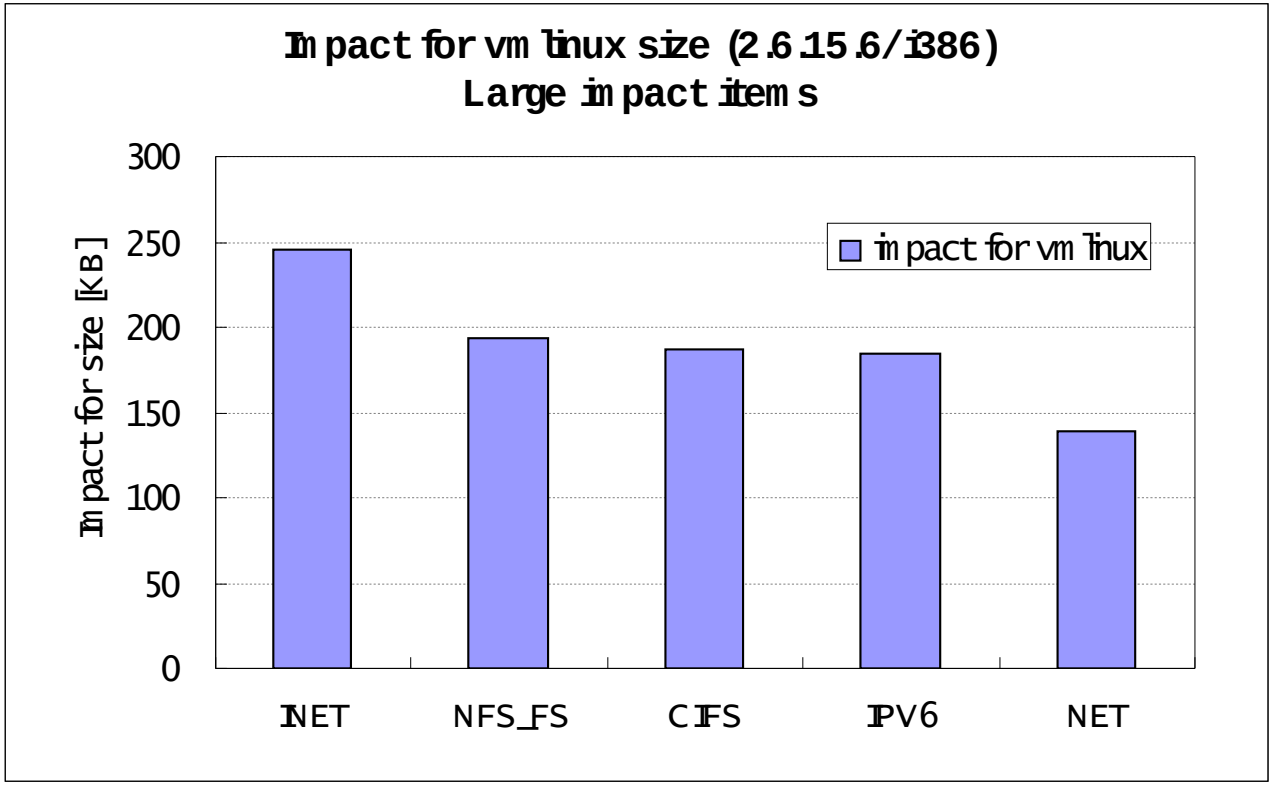
Examining result about size (2)

- **Large items**
  - Network features have larger impact.
  - Case study : TCP/IP support kernel
    - vmlinux size : 1700[KB]
      = 1300(minimal) + 250(INET) + 150(NET)
      … Network features' weight is 1/4 of total.



Note(1) : gcc 3.3.5, binutils 2.15

Note(2) : Some config items are not completely isolated.

```
INET    += IP_FIB_HASH + TCP_CONG_BIC
NFS_FS  += LOCKD + SUNRPC
IPV6    += CRYPTO + CRYPTO_MD5
```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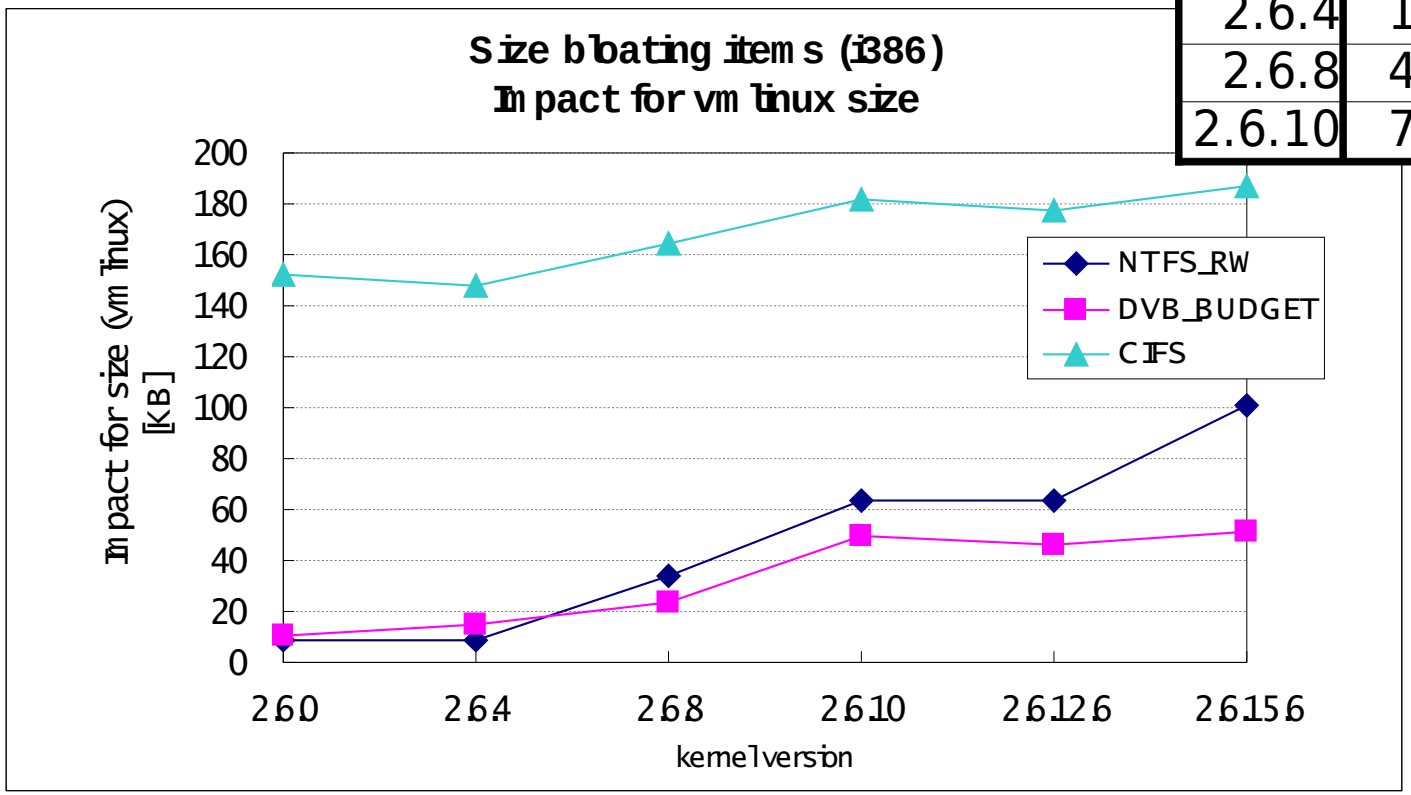
Examining result about size (3)

- **Bloating items**
  - Increase of NTFS_RW and CIFS may be caused by their active developments.
  - Increase of DVB_BUDGET seems to be caused by changing of config dependency.

Code lines

	NTFS_RW		CIFS	
	*.c	*.h	*.c	*.h
2.6.4	1433	5	14309	3922
2.6.8	4048	424	16905	4150
2.6.10	7634	622	19196	4304



Note : gcc 3.3.5, binutils 2.15

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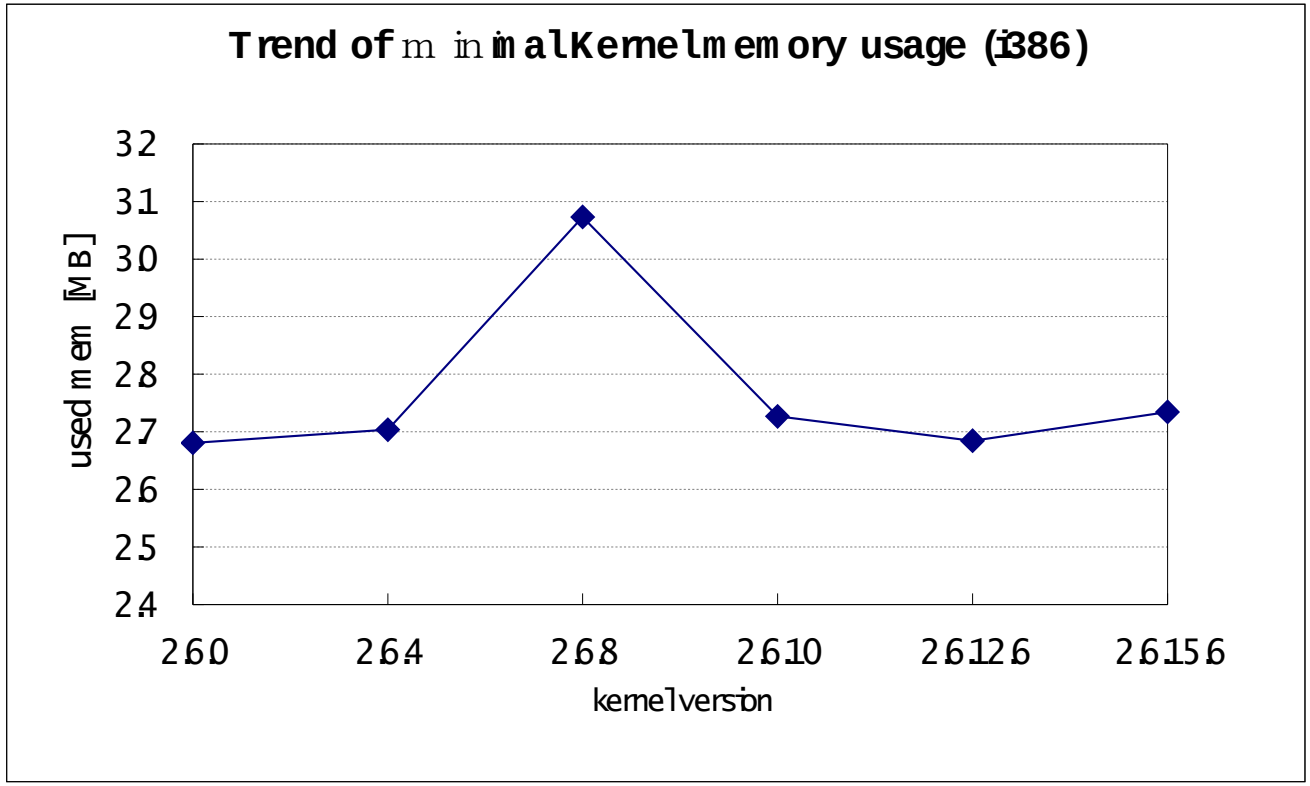
Examining result about memory usage (1)

- **Minimal kernel**
  - Memory usage hasn't increased from 2.6.0 to 2.6.15, stayed about 2.7[MB].
  - Peak at 2.6.8 is observed. (needs analysis)



Note(1) : gcc 3.3.5, binutils 2.15

Note(2) : Target machine
Pentium IV 2.2GHz
RAM 256MB/HD 40GB

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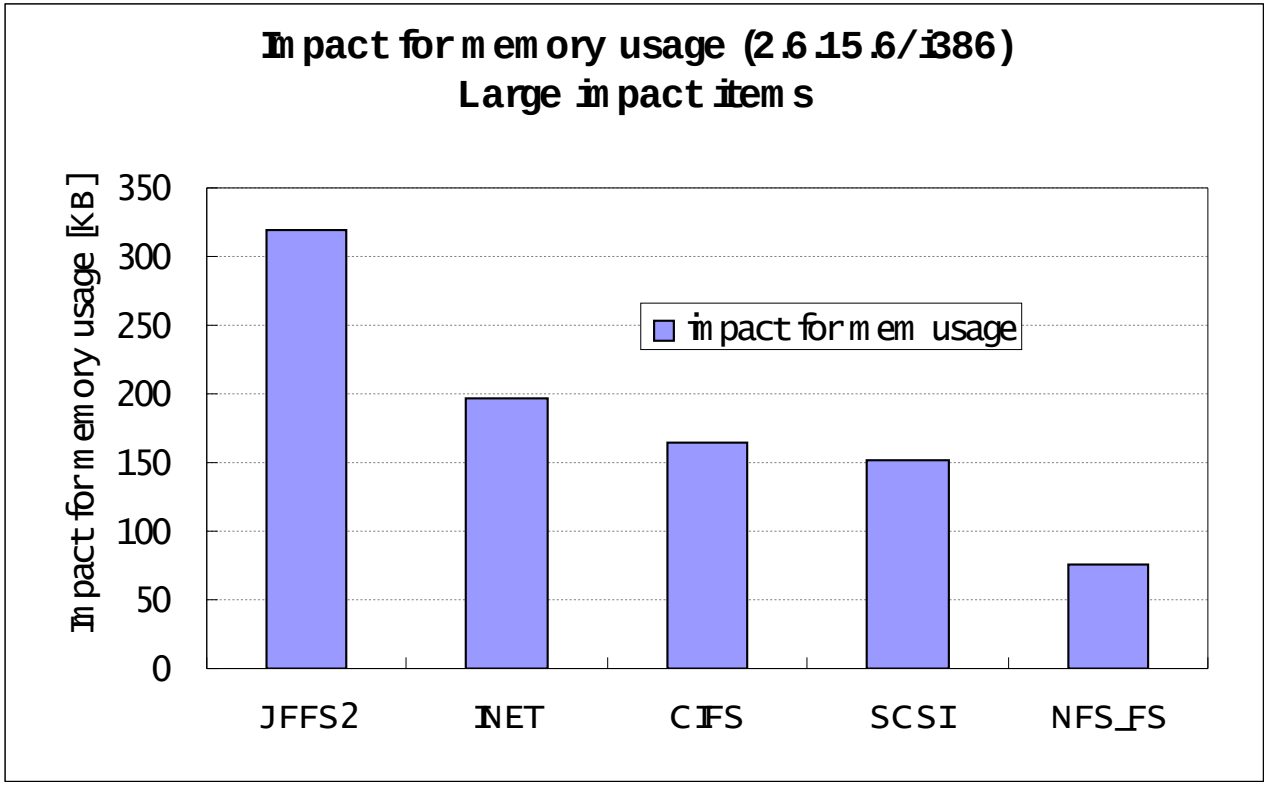
Examining result about memory usage (2)

- **Large items**
  - JFFS2, network features and SCSI have large impact for memory usage.
  - Case study :JFFS2 support kernel
    - Total memory usage : 3050[KB]
      = 2750(minimal) + 300(JFFS2)
      … JFFS2 has 10% weight of total.



Note(1) : gcc 3.3.5, binutils 2.15

Note(2) : Target machine
... Pentium IV 2.2GHz/RAM 256MB/HD 40GB

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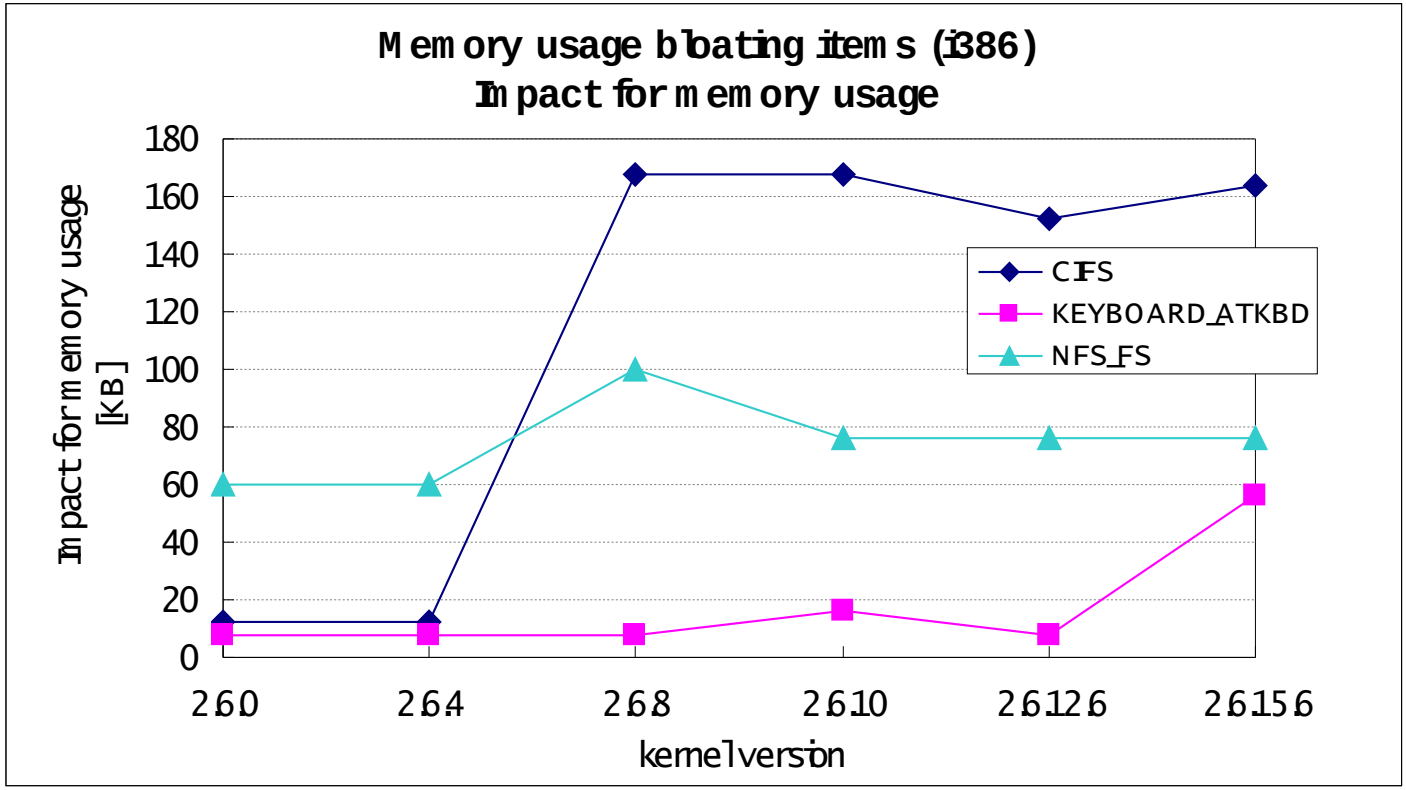
Examining result about memory usage (3)

- **Bloating items**
  - Memory impact of CIFS, KEYBOARD_ATKBD have been increased.
  - I guess the increase of CIFS is caused by active development.
  - The increase of ATKBD is curious.



Note(1) : gcc 3.3.5, binutils 2.15
Note(2) : Target machine
Pentium IV 2.2GHz
RAM 256MB/HD 40GB

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Further works

- **Periodic examination**
  - Tune the tool a little bit for automatic examination.
  - Provide and publish data periodically.
  - CELF Open Test Lab would be the best facility.
    - Providing data from 2 perspectives would be great.
      - Bloatwatch
        - » data per sub-system and symbol
          ⇒ mainly fits for kernel developers' perspective
      - KconfigSize
        - » data per config item
          ⇒ mainly fits for embedded engineers' perspective

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Appendix : resources

- **KconfigSize**
  - http://tree.celinuxforum.org/CelfPubWiki/KernelConfigWeight (slightly outdated, will be reorganized soon)

- **Bloatwatch**
  - Very smart kernel size measurement tool
  - Developed by Matt Mackall
    - source : http://selenic.com/repo/bloatwatch
    - actually works on : http://testlab.celinuxforum.org/

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Thank you !